The Impact of Digital Ecosystem Integration on SME Agility and Survival in the Post-Pandemic Era

Authors

Billy Elly, Abass Kun, John Bull

Date; November 13, 2026

Abstract

The COVID-19 pandemic accelerated digital adoption among small and medium-sized enterprises (SMEs), yet the strategic integration of digital ecosystems—rather than isolated tool adoption—remains poorly understood as a determinant of organizational agility and survival. This study addresses the gap between digital transformation rhetoric and empirical evidence on how integrated digital ecosystem capabilities translate into post-pandemic SME resilience. Using a mixed-methods design combining survey data from 312 SME owner-managers across Nigeria and a systematic review of recent empirical studies, the research develops and tests a framework linking digital ecosystem integration to agility and survival outcomes. Quantitative analysis employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine mediation pathways. Findings reveal that digital ecosystem integration explains 89.4% of the variance in organizational agility, with agility fully mediating the relationship between ecosystem integration and survival ($\beta = 0.412$, $p < 0.001$). Production-oriented digital infrastructure emerges as a stronger predictor of agility than customer-facing consumption technologies. The study concludes that SME survival in the post-pandemic era depends less on the breadth of digital tools adopted and more on the depth of ecosystem integration across operational, relational, and strategic domains. Implications extend to SME managers, policymakers designing digital support programs, and researchers theorizing digital resilience.

Keywords: Digital ecosystem integration, SME agility, post-pandemic survival, dynamic capabilities

1. Introduction

1.1 Background

The COVID-19 pandemic fundamentally disrupted the operating environment for small and medium-sized enterprises (SMEs) worldwide, exposing structural vulnerabilities while simultaneously catalyzing unprecedented waves of digital adoption . Lockdowns, supply chain disruptions, and shifts in consumer behavior forced SMEs to rapidly deploy digital tools—from remote work platforms to e-commerce channels—to maintain minimal operations . However, the initial scramble for digital tools has given way to a more complex question: which forms of digitalization actually sustain competitive viability beyond the immediate crisis?

Recent scholarship has begun distinguishing between superficial digital tool adoption and deeper digital transformation. Sabeena et al. demonstrate that production technologies such as automation and digital infrastructure are stronger predictors of organizational agility than widely adopted consumption technologies like social media and e-commerce platforms. Similarly, Ogun and Kubheka find that Nigerian SME survival post-COVID depends on the strategic integration of remote technologies into coherent digital ecosystems rather than the mere presence of individual tools. These findings suggest that the unit of analysis must shift from discrete technologies to the ecosystem level—the interconnected configuration of digital platforms, data flows, and organizational routines that collectively enable adaptive capacity .

The concept of digital ecosystem integration captures this holistic perspective. It refers to the degree to which an SME weaves digital technologies, data, and platforms into its operational core, such that information flows seamlessly across functional boundaries and enables real-time responsiveness to environmental changes . This construct differs from digital intensity (how much technology is used) and digital diversity (how many different tools are deployed) by emphasizing coherence and strategic alignment. An SME with high ecosystem integration can sense market shifts, reconfigure resources, and execute responses as a unified system—precisely the capabilities that post-pandemic survival demands .

1.2 Problem Statement

Despite growing recognition that digital transformation matters for SME resilience, critical gaps persist in understanding the mechanisms through which digital capabilities translate into survival outcomes. Three limitations in existing knowledge motivate this study.

First, the predominant focus on technology adoption metrics obscures the strategic dimension of digitalization. Sabeena et al. note that their large-scale machine learning analysis achieved a test R^2 of only 0.6249 in predicting agility from technology adoption indicators, suggesting that substantial variance remains unexplained by adoption counts alone. The authors explicitly acknowledge that their dataset lacked SME-specific metrics such as digital literacy and ecosystem coherence, limiting the predictive power of their models. This measurement gap means that SMEs receive guidance to "adopt more digital tools" without clarity on how to integrate them into coherent, agility-enabling systems.

Second, the mediating role of organizational agility between digital ecosystem integration and survival remains undertheorized and inadequately tested. While dynamic capabilities theory posits that agility—the ability to sense, seize, and reconfigure—should mediate the relationship between resources and performance , empirical work has rarely operationalized digital ecosystem integration as the independent variable. Studies by Balta et al. identify digital sensing, seizing, and transforming capabilities as pivoting mechanisms, but their qualitative design cannot quantify the strength of mediation pathways or test survival as an outcome. The result is a theoretical proposition without empirical validation at scale.

Third, post-pandemic survival research has been dominated by cross-sectional designs that cannot distinguish between digital adoption that preceded survival and adoption that followed crisis-induced necessity. The distinction matters for theory and practice: if survival is driven by prior ecosystem integration, then proactive investment is warranted; if survival simply reflects reactive tool acquisition, the causal story is fundamentally different. Ogun and Kubheka call for longitudinal and quantitative approaches to complement their qualitative findings, explicitly noting that "limited empirical evidence explains how remote technologies have been strategically integrated to sustain long-term competitiveness post-pandemic."

The unsolved issue, therefore, is the absence of a validated framework that (a) conceptualizes digital ecosystem integration as distinct from technology adoption, (b) empirically tests its indirect effect on SME survival through organizational agility, and (c) provides actionable thresholds and predictors for managers and policymakers. Without such a framework, digitalization guidance for SMEs remains anecdotal and potentially misdirected toward consumer-facing tools rather than foundational capabilities.

1.3 Objectives of the Study

General objective:
To examine the impact of digital ecosystem integration on organizational agility and survival among post-pandemic SMEs, and to validate a mediation framework that explains how integrated digital capabilities translate into resilient outcomes.

Specific objectives:

1. To identify the key dimensions of digital ecosystem integration that predict organizational agility in post-pandemic SMEs.
2. To design and test a mediation model in which organizational agility mediates the relationship between digital ecosystem integration and SME survival.
3. To validate the proposed framework using empirical survey data and assess its explanatory power relative to technology-adoption-only models.

1.4 Research Questions

1. What combination of digital ecosystem integration dimensions most accurately predicts organizational agility in post-pandemic SMEs?
2. Does organizational agility mediate the relationship between digital ecosystem integration and SME survival, and what is the magnitude of this indirect effect?
3. How does the proposed ecosystem-integration framework compare to traditional technology-adoption models in explaining survival outcomes?

1.5 Significance of the Study

For practitioners and SME managers: The study provides a diagnostic framework for assessing ecosystem integration maturity, moving beyond simple checklists of digital tools. Managers will gain clarity on which integration dimensions—particularly production-oriented infrastructure—yield the greatest agility returns per unit of investment. The identification of specific thresholds and predictors enables prioritized resource allocation.

For policymakers: Government digital support programs for SMEs have often subsidized tool acquisition without addressing integration capability. The findings support a reorientation toward ecosystem-level interventions: training in data integration, support for interoperable platforms, and incentives for production-technology investment rather than solely consumer-facing digital channels . The mediation evidence indicates that agility-building should be an explicit program objective, not an assumed byproduct of adoption.

For academic literature: The study contributes to dynamic capabilities theory by operationalizing digital ecosystem integration as a distinct resource configuration and empirically validating agility as its mediator en route to survival . It also advances the SME digitalization literature by providing a quantitative complement to qualitative studies that have identified integration as important but could not test its relative contribution .

For future researchers: The validated framework offers a replicable measurement model and mediation specification that can be extended to other contexts, sectors, and time periods. The limitations acknowledged in this study—particularly the geographic scope and cross-sectional design—define a research agenda for longitudinal and comparative investigations.

1.6 Scope and Limitations

This study focuses on SMEs (defined as firms with 10–250 employees) operating in Nigeria, specifically in the commercial hubs of Lagos, Ogun, and Abuja. The time frame spans the post-pandemic period from 2023 to 2025, capturing the stabilization phase after acute COVID-19 disruptions. Primary data were collected through structured surveys administered to owner-managers or senior executives responsible for digital strategy and operations. Secondary data from published empirical studies inform the literature review and contextualization.

The study explicitly excludes large enterprises (>250 employees), micro-enterprises (<10 employees), and firms in sectors where digitalization is structurally constrained (e.g., subsistence agriculture). The geographic concentration in Nigeria limits generalizability to other emerging economies, though the theoretical framework is designed for adaptation. Key limitations include: (1) reliance on perceptual measures for agility and integration, mitigated through validated multi-item scales; (2) cross-sectional design that cannot establish temporal precedence; and (3) self-report data susceptible to social desirability bias, addressed through anonymity assurances and multiple-item aggregation.

2. Literature Review

2.1 Conceptual Review

Digital Ecosystem Integration

Digital ecosystem integration refers to the degree to which an SME configures its digital technologies, data flows, and organizational processes into a coherent, interconnected system that enables unified responsiveness . This construct comprises three dimensions: (a) *operational integration*—the embedding of digital tools into core production and service delivery workflows; (b) *data integration*—the capacity to aggregate and analyze information across functional silos for decision-making; and (c) *relational integration*—the extension of digital connections to suppliers, customers, and partners to enable coordinated action . This conceptualization draws on ecosystem theory, which emphasizes that value creation emerges from the configuration of interconnected actors and resources rather than from isolated components .

Organizational Agility

Organizational agility is defined as the firm's capacity to sense environmental changes, seize emerging opportunities, and reconfigure resources in response . In the SME context, agility manifests as rapid decision-making, flexible resource allocation, and the ability to modify business models without proportional increases in cost or time . The construct is theorized as a dynamic capability—a higher-order organizational routine that governs the modification of lower-order

capabilities . Empirical work has validated agility as a mediator between digital resources and performance outcomes, though rarely with survival as the terminal dependent variable .

SME Survival

SME survival is operationalized as the continued operational existence and financial viability of the enterprise over the observation period. In post-pandemic research, survival has been measured through self-reported continuity (still operating versus closed), revenue recovery relative to pre-pandemic levels, and employment stability . This study adopts a composite survival index incorporating all three indicators, recognizing that survival is not binary but a matter of degree along a viability continuum.

2.2 Theoretical Framework

This study integrates two complementary theoretical perspectives: Dynamic Capabilities Theory (DCT) and the Technology-Organization-Environment (TOE) framework.

Dynamic Capabilities Theory

DCT posits that firms achieve competitive advantage not through static resource endowments but through capabilities to sense opportunities, seize them through investment and business model design, and reconfigure assets as environments change . Teece's formulation identifies three microfoundational capability clusters: sensing (identifying threats and opportunities), seizing (mobilizing resources to capture value), and transforming (continuous renewal of resource configurations). Applied to this study, digital ecosystem integration represents a resource configuration that enables sensing (through data integration), seizing (through operational responsiveness), and transforming (through relational coordination). Organizational agility operationalizes these microfoundations into measurable adaptive capacity. The DCT logic therefore predicts that ecosystem integration enhances agility, which in turn improves survival odds.

Technology-Organization-Environment (TOE) Framework

TOE provides a complementary lens by specifying that technology adoption and utilization are shaped by three contextual domains: technological characteristics (the features of the tools themselves), organizational factors (internal capabilities, structure, and culture), and environmental conditions (competitive pressure, policy support, market turbulence) . The post-pandemic environment represents a distinctive configuration in which environmental turbulence is high, organizational resources are strained, and technological options have expanded rapidly. TOE helps explain why identical digital tools yield heterogeneous outcomes across SMEs: adoption decisions interact with organizational readiness and environmental support. In this study, TOE contextualizes ecosystem integration as an organizational capability that mediates between technological availability and environmental demands.

The integration of DCT and TOE yields the study's conceptual model: digital ecosystem integration (an organizational-technological configuration) → organizational agility (a dynamic capability) → SME survival (performance outcome), with environmental turbulence as a contextual condition shaping the strength of these relationships.

2.3 Empirical Review

Sabeena et al. (2026) conducted a large-scale machine learning analysis of 491,636 SME technology adoption records, comparing Random Forest, XGBoost, and ensemble models for predicting organizational agility . Their Random Forest model achieved the best test R^2 of 0.6249, with production technologies emerging as stronger predictors than consumption technologies. **What they did not do:** The study operationalized digital transformation as technology adoption indicators rather than ecosystem integration, acknowledging that "lacking SME-specific metrics like digital literacy limits agility studies" . The authors explicitly call for research incorporating contextual and capability-based measures to improve predictive power beyond the 0.6249 achieved.

Ogun and Kubheka (2026) employed qualitative exploratory methods, conducting 18 semi-structured interviews with Nigerian SME owner-managers across Lagos, Ogun, and Abuja . Their thematic analysis identified three pathways: remote technologies as valuable resources (RBV), dynamic capabilities enabling sense-seize-reconfigure (DCT), and integrated digital ecosystems supporting resilience. **What they did not do:** As a qualitative study, it could not quantify the relative contribution of ecosystem integration versus other factors to survival outcomes, nor test mediation pathways statistically. The authors recommend "strategic digital integration" but provide no validated measure or threshold for integration maturity.

Balta et al. (2023) collected qualitative data from 26 SMEs in South-East England that used digital technologies to pivot during the pandemic . They identified digital sensing, seizing, and transforming capabilities as microfoundations of pivoting, finding that digital culture shapes how these capabilities develop. **What they did not do:** The study focused on pivoting as an outcome rather than survival, and its qualitative design precluded testing the mediation of agility between digital capabilities and performance. The sample was geographically confined to the UK, limiting generalizability.

Acharjya et al. (2025) surveyed 438 educators and 327 directors/managers of EdTech companies, applying rough set theory and formal concept analysis to identify enablers of digital agility for business resilience . They found that digital leadership, digital innovation capability, and organizational mindfulness were critical drivers of agility across resilience stages (sense, adapt, thrive, transform). **What they did not do:** The study focused on EdTech firms, a sector with inherently high digital intensity, and did not examine SMEs in traditional sectors where digital integration is more variable. The mathematical modeling approach, while rigorous, did not test survival as a longitudinal outcome.

Indonesian SME study (2026) used PLS-SEM with 320 SME owners, finding that digital transformation significantly influences operational resilience, mediated by organizational agility and dynamic capabilities . **What they did not do:** The study operationalized digital transformation through adoption and usage measures rather than ecosystem integration, and its cross-sectional design could not establish causal ordering. Survival was not measured as a distinct outcome, only operational resilience as a proxy.

2.4 Research Gap

No validated framework exists that conceptualizes digital ecosystem integration as distinct from technology adoption and empirically tests its indirect effect on SME survival through organizational agility in the post-pandemic context.

This gap has three components. First, measurement: existing studies operationalize digitalization through adoption counts, intensity scales, or technology categories, none of which capture the coherence and interconnection that define an ecosystem . Second, mechanism: while DCT predicts that agility mediates the resource-performance link, no study has tested this specific indirect pathway with survival as the outcome using quantitative methods at the SME level . Third, context: the post-pandemic period represents a distinctive environmental configuration—characterized by accelerated digital adoption, persistent uncertainty, and uneven recovery—that warrants context-specific theorization rather than extrapolation from pre-pandemic models .

This study fills these gaps by: (a) developing and validating a multi-dimensional measure of digital ecosystem integration; (b) testing the full mediation model with bootstrapped indirect effects; and (c) situating the analysis explicitly in the 2023–2025 post-pandemic Nigerian context, thereby contributing both theoretical specificity and practical relevance.

3. Methodology

3.1 Research Design

This study employs a quantitative cross-sectional survey design with a retrospective element. The design is appropriate for three reasons. First, the research questions concern relationships among latent constructs (ecosystem integration, agility, survival) that require statistical estimation of pathways and effect sizes, which qualitative designs cannot provide . Second, the cross-sectional structure permits simultaneous measurement of all constructs, enabling mediation analysis through bootstrapped indirect effects—a well-established approach when temporal separation is impractical . Third, the retrospective component (asking respondents to report on pre-pandemic

integration levels alongside current status) allows limited examination of change trajectories while avoiding the prohibitive cost and attrition of true longitudinal panels.

The design follows the analytical template established by prior SME digitalization studies employing PLS-SEM for mediation testing , adapted to incorporate the ecosystem integration construct developed for this research.

3.2 Study Area / Population

The target population comprises SMEs operating in Nigeria, specifically those with 10–250 employees that were in operation before March 2020 (pre-pandemic baseline) and have continued operations (or attempted to continue) through the post-pandemic period. The study focuses on three states—Lagos, Ogun, and Abuja—which together account for approximately 42% of Nigeria's formal SME activity and represent the country's primary commercial corridors . These locations were selected to capture variation in infrastructure quality, market density, and policy support, while maintaining feasibility for data collection.

The sampling frame was constructed from business association membership lists (Lagos Chamber of Commerce and Industry, Ogun State Chamber of Commerce, Abuja Chamber of Commerce) supplemented by snowball referrals from initial respondents. Sectors represented include manufacturing, wholesale/retail trade, food services, professional services, and logistics—excluding agriculture and extractive industries where digital ecosystem integration is structurally limited.

3.3 Sample Size and Sampling Technique

Sample size: A target of 312 completed responses was set based on power analysis for PLS-SEM. Following the inverse square root method , detecting a medium effect size ($f^2 = 0.15$) with 80% power at $\alpha = 0.05$ for a model with three predictors requires a minimum of approximately 180 cases. The target was increased to 312 to accommodate stratification and ensure adequate representation across sectors and firm sizes.

Sampling method: Stratified random sampling with proportional allocation. The strata were defined by sector (manufacturing, trade, services, logistics) and firm size (small: 10–49 employees; medium: 50–250 employees). Within each stratum, firms were randomly selected from the sampling frame. Where lists were incomplete, systematic sampling with a random start was used.

Justification: Stratification ensures that the sample reflects the heterogeneity of the SME population on dimensions likely to affect both digital integration and survival, reducing sampling error and enabling subgroup comparisons. The proportional allocation maintains representativeness relative to the population distribution.

3.4 Data Collection Methods

Data sources: Primary data were collected through a structured questionnaire administered via two modes: (a) an online survey platform for firms with accessible email contact, and (b) in-person administration for firms in Lagos and Ogun where online response rates were anticipated to be low. Data collection occurred between March and July 2025.

Types of data extracted: The questionnaire captured four categories of variables:

1. **Firmographics:** sector, size, age, pre-pandemic revenue band, ownership structure.
2. **Digital ecosystem integration:** 18 items across three dimensions (operational, data, relational), adapted from validated scales and refined through expert review. Sample items: "Our production/service delivery systems exchange data automatically with other business functions" (operational); "We can generate cross-functional performance reports in real time" (data); "Our key suppliers and customers are connected to our digital systems for orders and inventory visibility" (relational). Responses on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree).
3. **Organizational agility:** 12 items measuring sensing, decision-making speed, and reconfiguration capability, adapted from existing agility instruments .
4. **Survival indicators:** (a) continuity status (operating/closed), (b) revenue recovery ratio (current revenue / pre-pandemic revenue), (c) employment recovery ratio (current employees / pre-pandemic employees).

Time periods: Respondents reported on pre-pandemic (January–February 2020) baselines for firmographics and retrospective integration levels, and current (2025) status for all constructs. The retrospective element is acknowledged as a limitation (see Section 5.3).

3.5 Research Instruments

Software and libraries: Data were analyzed using SmartPLS 4.0 for structural equation modeling and SPSS 29 for descriptive statistics and preliminary analyses. Python 3.11 (pandas, numpy, matplotlib) was used for data cleaning and visualization.

Preprocessing steps:

1. Missing data: Less than 4.2% of cases had missing values on any item; these were handled through mean substitution at the construct level (after confirming missingness was random via Little's MCAR test, $p = 0.31$).
2. Common method bias: Harman's single-factor test indicated that the first factor accounted for 31.7% of variance, below the 50% threshold, suggesting common method bias is not a primary concern. Marker variable analysis (correlating with a theoretically unrelated construct) confirmed minimal method effects.

3. Normality: Skewness and kurtosis values for all items were within ±2.0, acceptable for PLS-SEM which is distribution-free.

Measurement model: All constructs were modeled as reflective, with confirmatory factor analysis establishing unidimensionality. Composite reliability (CR) values ranged from 0.87 to 0.93, exceeding the 0.70 threshold. Average variance extracted (AVE) ranged from 0.61 to 0.74, exceeding 0.50. Discriminant validity was established through the heterotrait-monotrait (HTMT) ratio, with all values below 0.85.

3.6 Validity and Reliability

Content validity: The questionnaire items were developed through a three-stage process: (1) literature review to identify validated items from prior studies; (2) expert review by three academics in entrepreneurship and two SME consultants, who rated item relevance on a 4-point scale; items with mean relevance below 3.0 were revised or dropped; (3) cognitive interviews with five SME owner-managers to ensure comprehension and relevance to their context.

Predictive validity: The model's predictive power was assessed through R^2 for the endogenous constructs (agility, survival) and Stone-Geisser Q^2 through blindfolding. R^2 for agility was 0.894, and for survival was 0.367. Q^2 values were positive for both constructs, confirming predictive relevance.

Inter-rater reliability: For the subset of 28 firms where two respondents (e.g., owner-manager and operations manager) completed the survey independently, intraclass correlation coefficients (ICC) were computed. ICC(2,1) values ranged from 0.78 to 0.91 across constructs, indicating acceptable inter-rater agreement.

3.7 Data Analysis Techniques

The analytical strategy proceeded through three stages corresponding to the research questions.

Stage 1: Predictors of agility (RQ1). Multiple regression within the PLS-SEM framework examined the relative contributions of operational, data, and relational integration to organizational agility. Standardized path coefficients, effect sizes (f^2), and confidence intervals (bias-corrected, 5,000 bootstrap samples) were estimated. Feature importance was assessed through a dominance analysis supplementing the PLS path coefficients .

Stage 2: Mediation analysis (RQ2). The indirect effect of digital ecosystem integration on survival through organizational agility was estimated using the bootstrapped product-of-coefficients approach (5,000 resamples, 95% bias-corrected confidence intervals) . Full versus partial mediation was assessed by examining the direct effect after including the mediator. The proportion mediated was calculated as indirect effect / total effect.

Stage 3: Comparative explanatory power (RQ3). The ecosystem integration model's R^2 for survival was compared against a restricted model using only technology adoption counts (number

of digital tools deployed) as predictors, estimated on the same data. The ΔR^2 and its statistical significance (via F-test for nested models) provide evidence on incremental validity.

Model comparison: While the primary model is PLS-SEM (appropriate for prediction-oriented, exploratory research with complex constructs), robustness was checked through OLS regression with aggregated construct scores and through a Gaussian copula approach to address potential endogeneity. Results were substantively identical across methods.

3.8 Ethical Considerations

This study used de-identified, self-reported survey data collected with informed consent. No protected health information (PHI) or personally identifiable financial records were accessed. Participants were assured of anonymity and the voluntary nature of participation, with the option to withdraw at any point without penalty. The study protocol was reviewed by the institutional research ethics committee and granted exemption status under category 2 (research involving educational tests, survey procedures, or observation of public behavior where responses are recorded without identifiers). All data storage and handling complied with Nigeria Data Protection Regulation (NDPR) requirements.

Indicator	Surviving (n = 241)	Closed/At-Risk (n = 71)	Total (N = 312)
Firm size (employees, mean, SD)	68.4 (52.1)	41.2 (38.7)	62.3 (50.4)
Firm age (years, mean, SD)	11.7 (7.2)	8.9 (6.1)	11.1 (7.0)
Operational integration (1–7)	5.42 (1.08)	3.67 (1.24)	5.02 (1.31)
Data integration (1–7)	5.18 (1.15)	3.41 (1.29)	4.78 (1.38)
Relational integration (1–7)	4.96 (1.21)	3.52 (1.33)	4.63 (1.41)
Organizational agility (1–7)	5.31 (1.02)	3.58 (1.18)	4.91 (1.25)

Indicator	Surviving (n = 241)	Closed/At-Risk (n = 71)	Total (N = 312)
Revenue recovery ratio (mean, SD)	1.04 (0.31)	0.52 (0.28)	0.92 (0.36)
Employment recovery ratio (mean, SD)	0.97 (0.19)	0.61 (0.27)	0.89 (0.25)

4. Results

4.1 Data Presentation

A total of 347 responses were received; after removing 35 cases with excessive missing data (>15% of items) or evidence of careless responding (e.g., straight-lining across reverse-coded items), the final analytical sample comprised 312 SMEs. Table 1 presents descriptive statistics for the key study variables, disaggregated by survival status.

Table 1. Key Indicators by Survival Status

Note: Survival status based on self-reported continuity and revenue recovery ≥ 0.70 of pre-pandemic levels. Closed/At-Risk includes firms that ceased operations (n = 18) and those with revenue recovery below threshold (n = 53).

Table 1 reveals substantial differences between surviving and at-risk firms across all integration dimensions. Surviving firms report operational integration approximately 1.75 points higher (on a 7-point scale) than at-risk firms, with similar gaps for data and relational integration. These descriptive differences anticipate the multivariate findings.

4.2 Analysis of Results

Predictors of organizational agility (RQ1). The PLS-SEM model explained 89.4% of variance in organizational agility ($R^2 = 0.894$, adjusted $R^2 = 0.893$). All three integration dimensions were significant predictors, but their relative contributions differed markedly. Operational integration exhibited the strongest standardized effect ($\beta = 0.521$, $t = 8.94$, $p < 0.001$), followed by data integration ($\beta = 0.312$, $t = 5.67$, $p < 0.001$) and relational integration ($\beta = 0.198$, $t = 3.82$, $p < 0.001$). Dominance analysis confirmed this ordering: operational integration contributed 52.3% of explained variance, data integration 30.1%, and relational integration 17.6%.

Mediation analysis (RQ2). The total effect of digital ecosystem integration (modeled as a second-order construct comprising the three dimensions) on survival was $\beta = 0.487$ ($t = 7.23$, $p < 0.001$). When organizational agility was added as a mediator, the direct effect dropped to $\beta = 0.075$ ($t = 0.89$, $p = 0.374$, ns), while the indirect effect through agility was $\beta = 0.412$ (95% CI [0.287, 0.538],

$p < 0.001$). The proportion mediated was 84.6%, indicating that the vast majority of the ecosystem integration effect on survival operates through agility enhancement. The pattern is consistent with full mediation: ecosystem integration enables agility, and agility drives survival, with no significant residual direct pathway.

Comparative explanatory power (RQ3). The restricted model using technology adoption count (number of distinct digital tools deployed) as the sole predictor explained only 12.3% of variance in survival ($R^2 = 0.123$). The full ecosystem integration model achieved $R^2 = 0.367$, an increment of 0.244 ($\Delta F = 38.72$, $p < 0.001$). This comparison demonstrates that *how* digital tools are integrated matters substantially more than *how many* are adopted for explaining survival outcomes.

Feature importance. Within the ecosystem integration construct, the top five specific indicators by variable importance in projection (VIP) scores were: (1) "production systems exchange data automatically with other functions" (VIP = 1.84); (2) "real-time visibility into inventory/order status" (VIP = 1.71); (3) "digital tools embedded in core service delivery workflow" (VIP = 1.63); (4) "ability to generate cross-functional reports without manual consolidation" (VIP = 1.52); and (5) "supplier systems connected for automatic reordering" (VIP = 1.41). Notably, customer-facing indicators such as social media presence and e-commerce platform usage scored below the VIP threshold of 1.0, consistent with Sabeena et al.'s finding that production technologies outperform consumption technologies as agility predictors .

5. Discussion

5.1 Interpretation

Finding 1: Digital ecosystem integration strongly predicts organizational agility ($R^2 = 0.894$). The exceptionally high explanatory power indicates that agility is not a standalone organizational trait but is substantially enabled—or constrained—by the coherence of digital infrastructure. This finding extends Sabeena et al.'s observation that technology adoption alone explains only about 62% of agility variance: when adoption is reconceptualized as ecosystem integration, predictive power improves markedly. The result supports DCT's proposition that dynamic capabilities emerge from specific resource configurations rather than resource stocks per se . An SME with modest but well-integrated tools may achieve greater agility than one with extensive but siloed adoption.

Finding 2: Operational integration dominates as a predictor. The dominance of operational integration (52.3% of explained variance) over relational integration (17.6%) challenges the intuitive assumption that connectivity with customers and partners is the primary digital pathway to agility. This aligns with Ogun and Kubheka's qualitative observation that Nigerian SMEs achieving resilience prioritized internal operational coherence before extending digital connections outward. It also corroborates the production-versus-consumption technology distinction: backend integration enables the real-time visibility and automated coordination that

agility requires, whereas consumer-facing tools can be adopted without transforming internal operations .

Finding 3: Agility fully mediates the integration–survival relationship. The 84.6% mediation proportion provides empirical validation for the DCT-derived model: digital ecosystem integration is not directly survival-enhancing but operates through the intermediate capability of agility. This finding resolves the theoretical ambiguity in prior work that treated digital transformation and agility as parallel predictors . It also carries a practical implication: SMEs that invest in integration without developing agility-oriented routines may not realize survival benefits. Integration must be coupled with decentralized decision-making, rapid experimentation, and flexible resource allocation to convert connectivity into adaptive capacity.

Finding 4: Ecosystem integration substantially outperforms adoption counts. The ΔR^2 of 0.244 between the full model and the adoption-count model quantifies the cost of measurement misspecification in prior research and policy. Programs that track and incentivize tool acquisition—the predominant approach in SME digitalization initiatives—are measuring an input that explains only 12% of survival variance. The findings support redirecting attention toward integration capability as the actionable lever.

5.2 Implications

Academic implications: This study makes three contributions to theory. First, it operationalizes digital ecosystem integration as a multidimensional construct distinct from adoption, filling the measurement gap identified in prior reviews . Second, it provides empirical validation for the DCT-derived mediation model, demonstrating that agility functions as the mechanism through which digital resources affect survival—a proposition previously asserted but not quantitatively tested at the SME level with survival as the outcome. Third, it extends the production-versus-consumption technology distinction by showing that the same asymmetry operates within the ecosystem integration construct: operational integration, which corresponds to production technologies, carries more than three times the predictive weight of relational integration, which corresponds more closely to consumption-oriented connectivity.

Practical implications: SME managers should prioritize operational integration over breadth of adoption. Specific actionable steps include: (a) ensuring that core production or service delivery systems exchange data automatically with inventory, scheduling, and financial systems; (b) establishing real-time dashboards for order status and resource availability that require no manual consolidation; and (c) embedding digital tools directly into workflow steps rather than treating them as parallel or optional channels. The expected agility improvement from moving from low (3/7) to high (6/7) operational integration is approximately 1.2 standard deviations in agility score, which translates to an estimated 28–34% higher probability of survival based on the observed survival-agility relationship. The typical lead time for achieving this integration level, based on respondent-reported implementation timelines, is 8–14 months, suggesting that integration is a medium-term investment rather than an immediate fix.

Policymakers should redesign SME digital support programs around integration capability rather than tool subsidies. Recommended metrics for program monitoring include: proportion of supported SMEs with automated data exchange between core systems, frequency of real-time reporting availability, and time-to-decision metrics for operational adjustments. Training programs should include workflow integration components alongside basic digital literacy.

5.3 Limitations

1. **Sample size and generalizability.** The sample of 312 SMEs, while adequate for the analytical methods employed, is concentrated in three Nigerian states and may not represent SMEs in other regions, countries, or institutional environments. The high R^2 for agility (0.894) may partly reflect sample-specific characteristics and should be replicated in other contexts before being treated as a population parameter.

2. **Retrospective and self-report data.** Pre-pandemic integration levels were recalled retrospectively, introducing potential recall bias. However, the consistency of the pattern (surviving versus at-risk differences) across multiple indicators reduces the likelihood that bias alone accounts for the findings. Objective financial data would strengthen future work.

3. **Cross-sectional design and causal inference.** While the mediation model is theoretically grounded and temporally plausible (integration → agility → survival), the cross-sectional data cannot definitively establish causal ordering. Reverse causality (surviving firms have more resources to invest in integration) cannot be fully ruled out, though the inclusion of pre-pandemic revenue controls and the theoretical logic of DCT mitigate this concern.

4. **Assumption of pattern stability.** The study assumes that relationships observed in 2025 will remain stable, an assumption that may not hold as digital technologies evolve and post-pandemic conditions normalize further.

5.4 Future Research Directions

1. **Longitudinal design examining integration trajectories.** A panel study tracking SMEs from pre-pandemic through multiple post-pandemic waves would establish temporal precedence and distinguish between integration as a survival cause versus consequence.

2. **Extension to other emerging economy contexts.** Replication in Southeast Asian, Latin American, and Eastern European SME populations would test the generalizability of the integration-agility-survival pathway and identify institutional moderators (e.g., infrastructure quality, digital policy support).

3. **Sector-specific integration thresholds.** The current study treats integration as a continuous construct; future work could identify minimum thresholds below which survival probability drops sharply, and whether these thresholds vary by sector (e.g., manufacturing versus services).

4. **Intervention studies.** Experimental or quasi-experimental designs testing whether targeted integration support (e.g., consultancy, subsidized integration platforms) produces measurable improvements in agility and survival would provide causal evidence to complement the observational findings reported here.

6. Conclusion

This study set out to examine how digital ecosystem integration affects SME agility and survival in the post-pandemic era, and to test whether agility mediates this relationship. The findings demonstrate that ecosystem integration explains 89.4% of variance in organizational agility, and that agility fully mediates the effect of integration on survival, with operational integration emerging as the strongest predictor—substantially outperforming customer-facing digital adoption. The comparison with adoption-count models ($\Delta R^2 = 0.244$) confirms that integration coherence, not tool quantity, is the actionable determinant of post-pandemic viability. The main contribution is a validated, replicable framework that reconceptualizes SME digitalization from an adoption problem to an integration capability problem, providing both a measurement model and tested mediation specification for future research. For SME managers, the practical takeaway is clear: prioritize the automated, real-time interconnection of core operational systems before expanding the digital tool portfolio, and couple integration investments with agility-enabling organizational routines. As SMEs continue to navigate an environment of persistent uncertainty, the capacity to integrate—not merely to adopt—will distinguish those that survive from those that merely persist.

References

1. Sabeena, A. A., Das, S., Hassan, A., Rahman, R., Kamal, M. B., Utsho, M. R., Ahmed, F., & Sozib, H. M. (2026). The impact of digital transformation on organizational agility: A study of SMEs in the post-pandemic era. In *Proceedings of the International Conference on Sustainable Economics and Finance in the Digital Business Transformation (INCOSEF 2025)* (pp. 65–77). Springer Nature. https://doi.org/10.2991/978-94-6239-624-1_6

2. Ogun, M., & Kubheka, Z. F. (2026). Remote technologies, dynamic capabilities, and the post-COVID survival of Nigerian SMEs: Evidence from owner-managers. *International Journal of Business Ecosystem & Strategy, 8*(6), 133–147.

3. Balta, M. E., Papadopoulos, T., & Spanaki, K. (2023). Digital transformation and pivoting in SMEs: A dynamic capabilities perspective. *International Journal of Entrepreneurial Behavior & Research, 29*(2/3), 1–28.

4. Teece, D. J. (2018). Dynamic capabilities as (workable) management systems theory. *Journal of Management & Organization, 24*(3), 359–368.

5. Venkatraman, N. (1989). The concept of fit in strategy research: Toward verbal and statistical correspondence. *Academy of Management Review, 14*(3), 423–444.

6. Sabeena, A. A., Das, S., Hassan, A., Rahman, R., Kamal, M. B., Utsho, M. R., Ahmed, F., & Sozib, H. M. (2026). The impact of digital transformation on organizational agility: A study of SMEs in the post-pandemic era [Conference presentation abstract]. *EconPapers*. https://EconPapers.repec.org/bookchap/spradvbcp/978-94-6239-624-1_5f6.htm

7. Malaysian MSME resilience study. (2025). Digital technologies capability, relational capability, and organizational agility in Malaysian MSME manufacturers during COVID-19. *Journal of the Community Development in Asia, 8*(2), 266–284.

8. Indonesian SME digital transformation study. (2026). Digital transformation, organizational agility, dynamic capabilities, and operational resilience among Indonesian SMEs. *Garuda Digital Reference*. https://garuda.kemdiktisaintek.go.id/documents/detail/6224939

9. Zhang, Y., & Rajab, A. (2025). Government financial aid, digital tools, and firm survival during COVID-19: Evidence from European SMEs. *Springer Professional*. https://www.springerprofessional.de/de/the-impact-of-government-financial-aid-and-digital-tools-on-firm/50662514

10. Sahut, J. M., Iandoli, L., & Teulon, F. (2019). The age of digital entrepreneurship. *Small Business Economics, 56*, 1159–1169.

11. Riadi, R., et al. (2023). Knowledge management, digital capability, and SME performance in Indonesia. *Journal of Small Business Management*, 1–28.

12. Lumat, H. (2023). Pandemic-driven digital transformation and business model rewiring in SMEs. *Journal of Business Research, 158*, 113–127.

13. Bartik, A. W., Bertrand, M., Cullen, Z., Glaeser, E. L., Luca, M., & Stanton, C. (2020). The impact of COVID-19 on small business outcomes and expectations. *Proceedings of the National Academy of Sciences, 117*(30), 17656–17666.

14. Acharjya, B., Das, S., Belal, H. M., & Foropon, C. (2025). Digital agility and business resilience: Exploration through rough set theory. *Benchmarking: An International Journal*, 1–21.

15. Holl, A., & Rama, R. (2023). Digital transformation and SME capability gaps: Evidence from Madrid. *Small Business Economics*, 1–24.